PART 536 - STRUCTURAL ENGINEERING

536.00 General.

(a) Technical assistance is provided in a variety of applications, but the structural features used are often repetitive and serve similar hydraulic purpose. The size range of the structural components frequently used is limited.

(b) Developing a series of construction drawings for structural components frequently used is an efficient way of providing technical assistance. The use of standard detail drawings based on conservative design assumptions to permit adapting to widely varying site conditions does not usually affect the total construction cost significantly.

(c) Standards of quality for engineering structures are established in structural detail drawings for construction plans. One of the ways the general quality of SCS construction can be maintained in a uniform manner and at an acceptable level is through the development and use of standard detail drawings.

536.01 Standard detail drawings.

(a) Standard detail drawings are detailed construction drawings according to standardized design assumptions. The design assumptions are to be selected so that the design and detail drawings for structures, spillways, and appurtenances will provide for the requirements of many sites.

(b) Standard detail drawings are essentially complete and are to be used directly in preparing construction drawings for contract purposes. They are to be complete in construction or fabrication detail.

(c) The structures in the drawings are to be designed to perform satisfactorily within the range of conditions assumed in their development. The assumed range of conditions is to be indicated in reference drawings, technical releases, or design notes. Include design assumptions and notes on material quality on the drawings.

(d) Portions of the drawings may provide for changes in size or length and thus require some additions for completion. These changes are not to affect the performance capability of the structure and are to be considered in the design. The provisions for these adaptations are to be incorporated into the drawings to facilitate their use. By including provisions for such adaptations, the coverage of a range of sizes may be completed with fewer drawings.

(e) Standards for reinforced-concrete drop-inlet spillway are to be consistent with Drawings Nos. ES-150, -151, -152, -154, -155, and -156.

(f) Each standard detail drawing is to be supported by design notes, computations, drawings, sketches, and other data. It is to be recorded and organized in a folder in a manner that allows reproduction and incorporation into a design folder (511.10 and 511.11(a)of this manual) for the entire job.

536.02 Use of standard detail drawings.

(a) Standard detail drawings are to be used when appropriate during the development of construction plans. The designer analyzes the site conditions, structure function, and hydraulic and structural requirements; examines the applicability of a standard detail drawing; and includes in the design notes the verification for the selection of a standard detail drawing or, if conditions differ significantly, the need for a special design.

(b) The approving engineer is to determine the appropriate use of standard detail drawings by considering:

(1) Acceptability of performance;

(2) Overall efficiency of design preparation and installation costs; and

(3) Risk of making errors during extensive modifications.

(c) Standard detail drawings are not to be developed by the state office or NTC if the drawings are available at the NTC or national level, respectively, for the same size and kind of structure, component, or appurtenance.

536.03 Adaptation of standard detail drawings.

(a) It is sometimes necessary to make additions to standard detail drawings by including reference-drawing numbers, notes, or details to minimize construction error. These additions usually should not affect the hydraulic or structural performance as originally designed.

(b) If an adaptation of the standard detail drawing affects the hydraulic or structural performance of the original design, document the effects if the adaptation by amending the original design notes and computation from the drawing and incorporating the amendments into the design folder for the entire job. This documentation is to include the new or differing design assumptions, the adaptations and modifications, the effect of the modification on the original design assumptions, and the analysis and design of the structure to insure adequate performance.

536.04 Revision of standard detail drawings.

Standard detail drawings need periodic review and revision to meet current design needs and to be compatible with current construction practices. The use of the drawings provides for such a review. Identified errors and suggestions for improvement are to be forwarded to the office responsible for preparing the drawing.

536.05 Availability of standard detail drawings to the public.

(a) Requirements of the Freedom of Information Act make copies of standard detail drawings available to the public on demand. Copies of the drawings are to be made available, when requested, in accordance with the procedures in 120-408--Subpart (c)

(b) Each drawing provided is to include the following information:

(1) A precautionary statement: STANDARDIZED DESIGNS - Must be Adapted to the Specific Site

(2) The material design strength and quality assumptions.

(3) The site conditions assumed in the design.

(4) The name and address of the office in which the folder containing design notes and computations is available.

536.06 National standard detail drawings.

(a) Standard detail drawings are prepared for structures, spillways, and appurtenances. These drawings are prepared according to hydraulic and structural design criteria in the NEH, technical releases, or design notes. The drawings are prepared to permit direct use without any significant change.

(b) The drawings may be prepared as a series to provide the range of sizes frequently needed. The kind of structure and range of sizes is to be determined by the Director of Engineering.

(c) Drawings are available to the state design offices and NTC's for use in preparing plans for specific structures. Polyester transparencies of the detail drawings are to be requested only as needed for each job. The original drawings are to be kept on file in the Design Unit, Engineering Technology Development Staff, National Headquarters. A duplicate set of drawings, as listed in Technical Release No. 40, is to be maintained on file in each NTC. Indexes of available standard detail drawings are in Design Note 18.

536.07 NTC standard detail drawings.

(a) As approved by the Director of Engineering, NTC standard detail drawings are to be prepared for structures and appurtenances that would

be usable by more than one state. These drawings are to be complementary and supplementary to those provided nationally (i.e., not replaced in kind). The drawings are to be prepared as requested by state offices or initiated by the head of the NTC engineering Staff to meet a common need.

(b) The folder containing the design notes and computations made during the preparation of standard detail drawings is to be kept on file for reference as long as the drawings are available.

(c) The NTC is to provide to the state offices a current index of approved drawings.

536.08 4100 Series standard drop-spillway drawings.

(a) The 4100 Series standard drop spillway is an alternative to the Type B series standard in NEH-11. The 4100 Series reference is from index drawing 3-L-4100, issued by the Milwaukee Regional Office and later reissued as drawing 5-N-4100.

(b) After the 4100 Series was issued, research revealed that the tendency for scour to occur downstream from the apron increases as the ratio of the depth of the weir to the height of the headwall increases. Therefore, the 4100 Series is to be used only if the ratio of weir depth to headwall height is lower than 0.5. (See NEH-11, Chapter 5, page 5.1.)

(c) Some 4100 Series structures have headwall extension lengths less than that required by the criteria for Type B structures in NEH-11. If metal is used as an alternative material for this type of structure, the headwall extension lengths must meet the minimum standards established for the Type B structure.

(d) The requirements of the site and the suitability of the structure are to be verified before use.

536.09 State standard detail drawings.

(a) Standard detail drawings are to be prepared only for structural appurtenances and details that are frequently used and for which such drawings are not available nationally or through the NTC. The design supporting the drawings is to be in accordance with all SCS design procedures, criteria, and materials specifications. The quality of drafting is to be consistent with national and NTC drawings. Standard detail drawings are not to be prepared to duplicate the kind or size of either the national or the NTC drawings or to be equivalent to them in purpose and function.

(b) The folder containing the design notes and computations made during the preparation of these drawings is to be kept on file for reference as long as the drawings are available.

(c) A current index of standard detail drawings prepared by a state is to be maintained by that state. The head of the NTC engineering Staff is to receive a copy of the index from each state and distribute a consolidated index to the states in the NTC work area, other NTC's, and the Director of Engineering.

(d) The index of state standard detail drawings is to contain the following:

(1) Name or type of structure, structure element, or appurtenance.

(2) State responsible for the design.

(3) Data of design.

(4) Location of folder containing design notes and computations.

(5) Types of materials used in the structure or element, size ranges, general application, and significant limiting assumptions.

(6) Indication of whether or not the head of the NTC engineering Staff has reviewed and concurred in the drawing.

(e) The state conservation engineer should review the NTC consolidated index and, as appropriate, request from the responsible state a copy of the desired standard detail drawing When a standard detail drawing prepared by another state is selected for use, a copy of the folder with design notes and computation is to be obtained to support the use of the drawing.

(f) The use of state standard detail drawings in Class VI and VII jobs is to be concurred in by the head of the NTC engineering Staff. Concurrence may be obtained through agreements reached during the designing of individual jobs (501.04 (c) of this manual) or by a special review requested by the state conservation engineer. A request for a special review is to be accompanied by documentation indicating the frequency of the drawings' use in Class VI and VII jobs.

536.10 Standard detail drawings prepared by non-SCS engineers.

(a) Standard detail drawings are prepared by other engineering organizations, vendors, or fabricators. The drawings are for structures and structural elements or appurtenances frequently used in construction drawings for conservation practices and systems but not portrayed in SCS standard detail drawings. The design documentation supporting the drawings and the materials used in the structures or appurtenances are to meet minimum SCS criteria and should be of professional quality. Drafting is to be professional.

(b) A folder of design notes and computations is to be completed during the design and preparation of the drawing. The folder is to be

prepared professionally and must be of professional quality. The folder is to be kept on file for reference as long as the drawing is available for use.

(c) The state conservation engineer is to review and concur in any use of standard detail drawings prepared by non-SCS engineers. In conducting the review, the state conservation engineer may request assistance from the NTC. Such requests are to be accompanied by documentation indicating the frequency of use and an estimate of the regional application of the drawing. All drawings must be accompanied by a folder containing design notes and computations.

(d) Use of standard detail drawings prepared by non-SCS engineers in Class VI and VII jobs is to be concurred in by the head of the NTC engineering Staff. Concurrence may be obtained through agreements reached during the design process of the individual job (501.04 (c) of this manual) or by a special review requested by the state conservation engineer.

(e) An index of currently use standard detail drawings prepared by non-SCS engineers is to be maintained by the state conservation engineer. The head of the NTC engineering Staff is to receive a copy of the index from each state and distribute a consolidated index to states in the NTC areas, other NTC's, and the Director of Engineering.

(f) The NTC's index of standard detail drawings prepared by non-SCS engineers is to contain the following information:

(1) Name and type of structure, structural element, or appurtenance.

(2) Name and address of designer.

(3) Name and address of the vendor, distributor, or fabricator.

(4) Identifying name and number of the drawing.

(5) Date of original design and all revisions.

(6) Location of the folder containing design notes and computations.

(7) Type of materials used in the structure or element, size ranges, general application, and significant limiting assumptions.

(8) Indication of whether or not the head of the NTC engineering Staff has reviewed and concurred in the use of the drawing.

(g) The state conservation engineer should review the NTC consolidated index and, as appropriate, request from the state, vendor, or fabricator a copy of the desired standard detail drawing. When a standard detail drawing so obtained is to be used, the state conservation engineer is to

obtain a copy of the folder containing the design notes and computations, including design assumptions that identify the limitations for use of the structure or elements.

536.11 (Reserved.)
536.12 (Reserved.)
536.13 (Reserved.)
536.14 (Reserved.)
536.15 (Reserved.)
536.16 (Reserved.)
536.17 (Reserved.)
536.18 (Reserved.)
536.19 (Reserved.)

536.20 Design criteria for reinforced concrete.

(a) The structural design of reinforced concrete structures is commonly guided by the ACI Standard, Building Code Requirements for Reinforced Concrete (ACI 318) developed by Committee 318 of the American Concrete Institute. This code covers the design and construction of buildings. The code provides minimum requirements and contains several precautions about special attention needed when corrosive environments or other severe exposure conditions exist. SCS uses reinforced concrete in hydraulic structures for components of water resource projects. These structures are often subject to severe exposure. Because of the type of structure usually involved, design must often exceed the minimums required by building codes.

(b) Concrete is to be designated by class. The class corresponds to the compressive strength assumed in the design and specified in construction. The class selected for use is to be determined by evaluating the requirements for strength and durability. The availability of materials and construction quality control must also be recognized in making the determination. The strength values normally used are 2,500, 3,000, 4,000, and 5,000 pounds per square inch (psi).

(c) With one exception contained in the criteria for waste storage structures, structural design in reinforced concrete may be carried out by either strength design or working stress design methods.

(1) For waste storage structures, design is to be in accordance with Practice Standard 313, Waste Storage Structure, contained in the National Handbook of Conservation Practices.

(2) For Service hydraulic structures, the design yield strength, fy, is to be taken as 40 kips per square inch (ksi) for grade 40, grade 50, or grade 60 steels. The only exception to this general requirement is for a special design at critical locations where higher yield strengths will reduce excessive congestion of reinforcement and the potential for accelerated deterioration due to increased flexural cracking is acceptable.

(i) The strength design method is to be in accordance with the requirements of Technical Release No. 67, Reinforced Concrete Strength Design.

(ii) The working stress design method is to be in accordance with requirements of NEH Section 6, Structural Design, subsection 4, Reinforced Concrete, as updated by National Engineering Handbook Notice 6-4.

(3) For other structures--with uncontrolled environments, the design yield strength, fy, may be taken in accordance with the grade of steel specified for construction.

(i) The strength design method is to be in accordance with the requirements of Technical Release No. 67, Reinforced Concrete Strength Design, except that temperature and shrinkage steel may be in accordance with ACI Standard, Building Code Requirements for Reinforced Concrete (ACI 318-77).

(ii) The working stress design method is to be in accordance with the ACI Standard, Building Code Requirements for Reinforced Concrete (ACI 318-77), Appendix B - Alternate Design Methods, except that the allowable extreme fiber stress in compression is to be f'c = 0.40 fc and the Z factor controlling flexural crack widths is not to exceed 145.

(4) For other structures--with controlled environments, design is to be in accordance with the ACI Standard, Building Code Requirements for Reinforced Concrete (ACI 318-77).

(d) The following additional criteria are to be used in the design of Service hydraulic structures.

(1) Reinforcing steel is required in both faces and in both (orthogonal) directions in all concrete slabs and walls, except that only one grid of reinforcing steel is required in:

(i) concrete linings of trapezoidal channels, and

(ii) structures of Class V or less, as defined in 501.04 of this manual, if authorized by the state conservation engineer (SCE). If authorized by the SCE under this exception, a single grid of steel reinforcement is permitted in slabs or walls having a maximum thickness of 8 inches, provided the steel is positioned approximately in the middle of the wall and strength and durability requirements are satisfied.

(2) Redistribution of moments in continuous members is not permitted in either:

(i) The strength design method when grade 50 or grade 60 steels are specified for construction and the design yield strength, f_y, is taken as 40 ksi, or

(ii) The working stress design method.